Processing wheat proteins into sustainable materials

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The unique properties of the wheat grain reside primarily in its gluten-forming storage proteins. Besides the application of gluten in a range of food products, its visco-elastic properties and low-water solubility are also interesting features for non-food applications. Moreover, gluten is annually renewable and perfectly biodegradable. In this presentation the impact of gluten processing conditions on its structure and rheological properties is discussed. We discuss two main technological approaches to make gluten-based materials: wet processes resulting in rubbery materials and dry processes, such as compression molding, exploiting the thermoplastic properties of proteins under low moisture conditions and resulting in rigid materials. Gluten proteins represent a heterogeneous mixture of single-chained proteins, the gliadins, and multi-chained glutenin proteins that consist of different peptide chains (subunits) associated through interchain SS bonds. Not only the structure of the gluten constituents varies considerably, the molecular diversity of the amino acids also leads to a variety of chemical reactions. Moreover, being thermoplastic heteropolymers, proteins have the potential to cross-link yielding a wide range of functional properties. Upon thermosetting of fully plasticized or wet gluten, aggregation proceeds through direct covalent cross-linking between its glutenin and gliadin protein subgroups. Alkaline conditions and high temperatures are often applied in the production of gluten-based bioplastics during wet processing and affect their final material properties. This is illustrated by more protein cross-linking and stronger gluten bioplastic at alkaline pH. When wheat gluten is thermomolded at low moisture contents also heat-induced cross-linking in wheat gluten results in larger molecules. In contrast to wet processing, the modulus of the rigid material is not affected by the processing parameters, while both strength and failure strain are related to the degree of protein cross-linking.